



# **Monitoring Northern Spotted Owls on Federal Lands in Marin County, California**

## ***2007 Annual Report***

Natural Resource Technical Report NPS/PWR/SFAN/NRTR—2008/089



**ON THE COVER**

Northern spotted owl pair (*Strix occidentalis caurina*)

Photograph by: Heather Jensen, NPS

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## Executive Summary

This report details the results of the eleventh year of the northern spotted owl (*Strix occidentalis caurina*) monitoring program in Marin County, California. The goal of the 2007 monitoring effort was to estimate trends in spotted owl occupancy rates and productivity within the National Park Service (NPS) legislative boundary (includes portions of Mt. Tamalpais and Samuel P. Taylor State Parks) in Marin County. The intended audience of this report includes appropriate agencies at the county, state, and federal levels. The report provides an overview of the 2007 northern spotted owl monitoring program on federal lands and summarizes the results of the data collected during the field season.

A randomly selected subset of 25 spotted owl territories located within the NPS legislative boundary of Marin County was designated for monitoring in 2007 under our long-term monitoring program. Survey teams made 137 visits to determine occupancy and reproductive status at the 25 territories (“sites”). An additional five sites were monitored based on resource management requests or needs of the land management agencies involved in the project. For this report, only information pertaining to the 25 long-term monitoring sites was included. The official status of each spotted owl territory monitored in 2007 was determined using the “Modified Protocol for Spotted Owl Monitoring and Demographic Studies in Marin County California” (Fehring et al. 2001).

Researchers on federal lands in Marin County did not document any successful nesting, nesting attempts, or young in 2007. This is the first year a non-breeding season has been documented since the onset of this monitoring program in 1998. Pairs of spotted owls occupied 72% or 18 of the 25 long-term monitoring sites. Five sites (20%) were occupied by single owls and two sites were unoccupied in 2007. Of the 14 females with known reproductive status, which included one non-nesting (resident single) female, all 14 females were confirmed non-nesting. The mean fecundity for the 2007 breeding season was 0.00 (n=14). From 1998 to 2005, the mean fecundity measured at long-term monitoring sites in Marin County remained relatively stable, with an average fecundity of 0.46 (SE  $\pm$ 0.078). Fecundity ( $\pm$  SE) is defined as the number of female young fledged per territorial female.

The number of known barred owls (*S. varia*) on federal lands in Marin County is currently three adults (a pair and a single male). In 2007, barred owls responded from four previously known spotted owl/barred owl sites and were not detected at any new locations. Barred owls were detected on a total of seven spotted owl surveys. At one site, we found evidence of barred owl reproduction and documented a maximum count of two fledglings. This was the first documented barred owl reproduction within the study area.



## Acknowledgements

This project is made possible by funding from the following organizations: San Francisco Bay Area Network Inventory and Monitoring Program, Golden Gate National Parks Conservancy, Point Reyes National Seashore Association, and the David and Vicki Cox Family Foundation. The NPS monitors spotted owls in cooperation with PRBO Conservation Science, Marin Municipal Water District, Marin County Open Space District and California State Parks.

This project is possible through the assistance of, Mia Monroe, as well as numerous field staff from previous years. Daniel George of NPS designed our database and additional field guidance and supervisory contributions have been made by Sarah Allen, Geoff Geupel, Daphne Hatch, Marcus Koenen and Mia Monroe. Special thanks to the long-term commitment of the 2007 Muir Woods National Monument (MUWO) volunteers including: Jim White, Donna and Tim Lyons; Dave and Bonnie MacKenzie; and Stephan Meyer. Thanks to Deborah Zierten who helped with surveys at Golden Gate National Recreation Area (GOGA). Last, but not least, thank you to Dash Feierabend, Dan Munton, Matt Divens, and Rick Johnson for their assistance on surveys at Point Reyes National Seashore (PORE).



# Introduction

Northern spotted owls (*Strix occidentalis caurina*) are distributed in forested regions from southern British Columbia through Washington, Oregon, and northwestern California. They reach the southern limit of their range in coastal California north of San Francisco Bay, where they occur in Golden Gate National Recreation Area (GOGA), Muir Woods National Monument (MUWO), Point Reyes National Seashore (PORE), and other parts of Marin County.

In a 1997-1998 spotted owl inventory study, all evergreen forest habitat located on federal lands within Marin County was thoroughly and systematically surveyed for spotted owl presence using the USFWS “Protocol For Surveying Proposed Management Activities That May Impact Northern Spotted Owls” (USFWS 1992). Additional surveys on Marin Municipal Water District (MMWD) and Marin County Open Space District (MCOSD) were completed in 1999. Through the inventory process a total of 83 spotted owl sites, including 53 pairs, were identified on public lands in Marin County.

Between 1999 and 2005, 46 long-term monitoring sites were monitored for occupancy and reproductive success to determine overall population occupancy rates and fecundity and to collect nest site characteristics (Jensen et al. 2005). The sites were chosen to represent a variety of habitat types and according to the amount of existing data, ongoing management concerns, accessibility, and funding availability. Due to the non-random selection process of the 46 sites, this monitoring design could not be used to make valid inference across federal lands in Marin County. As a result, the program sought a sample design to increase efficiency and potentially decrease the annual effort and cost of monitoring spotted owls on federal lands in Marin County (Adams et al. 2005).

To create a within-subject study design to detect trends toward a decline in fecundity, we first completed a single year inventory study in 2006 to assess the spotted owl population on all suitable habitat located on federal lands or within 400 meters of the NPS legislative boundaries (Jensen et al. 2006). This single year inventory effort was designed utilizing a model that predicted the high occurrence of spotted owl occupancy based on habitat suitability (Stralberg et al. in prep). To redefine the study area, we applied a 400 meter buffer around the habitat model’s boundary and restricted our study area to include buffered lands within 400 meters of the legislative boundary of MUWO, PORE, and GOGA. As a result, 65 areas which included 43 known spotted owl territories and 22 inventory areas were inventoried for occupancy in 2006. At a minimum, a single spotted owl was detected at 59 of the 65 areas, and pairs occupied 43 territories. In 2007, a randomly selected subset of 25 long term monitoring sites was obtained from 47 spotted owl sites with pair occupancy at least one year from 1997-2006.

## Current Monitoring Objectives

1. Monitor changes in northern spotted owl abundance and reproductive success at known owl activity sites within the NPS legislative boundaries of Marin County, California.
2. Determine the long-term changes of nest site characteristics (e.g. tree species selected for nest sites, vegetation community selected for nest sites) at northern spotted owl known activity sites in order to evaluate habitat selection.

3. Monitor suitable habitats every 5-10 years in order to identify population expansion of target species and incorporate them into annual abundance estimates.

## Habitat and Nests

In the northern portion of their range, northern spotted owls are typically found in mature coniferous forests (e.g., Forsman et al. 1984). In Marin County, they inhabit Douglas fir (*Pseudotsuga menziesii*), coast redwood (*Sequoia sempervirens*), bishop pine (*Pinus muricata*), mixed conifer-hardwood, and evergreen hardwood forests. Logging occurred in Marin County from the mid 1800's to the mid 1900's, a large fire burned in the mid 1940's, several smaller fires occurred in owl habitat in the 1940's to 1960's, and another 12,000 acre fire occurred in 1995, all of which altered forested habitats (Evens 1988). Most of the areas altered prior to the 1940's have re-grown and are now mature second growth. The area where the Vision Fire occurred in 1995 contains a mosaic of young, dense stands of mixed conifer-hardwood forest and coastal scrub. All forest types and ages contain a significant hardwood component.

During inventory and monitoring surveys from 1997 to 2005, spotted owl researchers located a total of 195 spotted owl nests. The years of 2006 to 2007 are not represented here since reproductive information was only collected opportunistically in 2006, and in 2007, biologists did not find evidence of spotted owl nesting. Of the 195 unique nests, 19 (9%) have been cavities and 176 (91%) have been platform nests.

Platform nesting structures in Marin have included tree forks, large limbs, broken top trees with lateral branches, old raptor, corvid, squirrel, and woodrat nests, debris piles, poison oak tangles (*Toxicodendron diversilobum*) and dwarf mistletoe infestations (*Arceuthobium* spp.). Cavity nests included both side entry and top entry cavities. Spotted owl nests have been documented in a variety of tree species including coast redwood, Douglas fir, bishop pine, California bay (*Umbellularia californica*), tanbark oak (*Lithocarpus densiflorus*) and coast live oak (*Quercus agrifolia*). Approximately 80% of the documented nests have been in coast redwood and Douglas fir.

The habitat and nest data collected through the monitoring program has been used to quantify the known and predicted distribution and density of owls through Geographic Information Systems (GIS) analysis, and a habitat model was developed in cooperation with PRBO Conservation Science (Stralberg et al. in prep.) The models indicated that forest connectivity and topographic conditions were the strongest predictors of owl presence. We are characterizing habitats around owl nest sites through GIS analysis and in the future hope to relate reproductive success to specific habitat characteristics.

The Marin County study area supports the highest density of northern spotted owls within this subspecies' range (Blakesley et al. 2004). Based on a recent analysis, the density of spotted owl activity sites was estimated at 0.52 owls/km<sup>2</sup> which is slightly higher than a previous Marin County estimate due to the discovery of several additional owl sites and the use of a more limited, geographically relevant boundary for the study area (Chow 2001; Stralberg et al. in prep.)



## Prey Species

Previous pellet analyses indicate that spotted owls in Marin County forage primarily on dusky-footed woodrats (*Neotoma fuscipes*) which make up over 75% of their diet by weight. Other prey includes small mammals such as deer mice (*Peromyscus maniculatus*), California meadow vole (*Microtus californicus*), and brush rabbit (*Sylvilagus bachmani*) as well as a variety of forest-dwelling birds (Chow and Allen 1997, Fehring 2003).

## Threats to the Population

Marin County's northern spotted owl population is subject to unique threats present in this portion of the range including: 1) urban development along open space boundaries, 2) disturbance due to intense recreational pressures, 3) potential effects of hazardous fuel management practices to spotted owl distribution and productivity, 4) potential for catastrophic wildfires along the urban/wildland interface, 5) possible genetic isolation and 6) emergent biological threats (sudden oak death, West Nile virus, and the continued range expansion of the barred owl).

Feather samples collected in 1999 and 2000 from Marin County's population were part of a study conducted at the Conservation Genetics Laboratory at San Jose State University. The Conservation Genetics Lab compared Marin County's northern spotted owl population with other populations of northern and California spotted owls. Their results indicated that the Marin County spotted owl population has very little gene flow with spotted owl populations farther to the north (Henke et al. 2003, Barrowclough et al. 2005). Barrowclough et al. (2005) indicated that due to the apparent genetic isolation of Marin County's northern spotted owl population, the population warrants special management attention.

The long-term ramifications of emergent biological threats in Marin County, such as sudden oak death (SOD), West Nile virus (WNV), and the continuing range expansion of the barred owl, are not yet fully understood at this time. SOD involves the continuing die-off of tanbark oaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and several other tree and shrub species throughout spotted owl habitat in Marin County. SOD may have long-term impacts on spotted owl nesting habitat and prey populations. WNV has been confirmed to be lethal in the Strigidae family and the first positive confirmations of WNV occurred in 2004 in Marin County. Of special concern are interactions between spotted owls and barred owls (Anthony et al. 2006). Barred owls have expanded their range into the Pacific Northwest, and are suspected of displacing spotted owls. In reviewing barred owl and spotted owl locations in Oregon between 1974 and 1998, Kelly et al. (2003) found that when barred owls invade spotted owl territories, mean annual occupancy of spotted owls decline when compared to territories without barred owls.

The parklands in this portion of the spotted owl's range are situated within the immediate San Francisco Bay Area and receive several million human visitors each year. Spotted owl nest sites in Marin County are generally close to roads and trails. This is likely the result of the high density of trails and fire roads located within potential spotted owl habitat and the tendency to

locate trails in riparian drainages where owls often nest. As a result of these circumstances, spotted owls of this region have a high potential for interaction with humans.

Standard spotted owl survey protocols may lead to changes in owl behavior due to repeated calling and the feeding of live mice (*Mus domesticus*) to owls (known as “mousing”). Owls habituated to people may be more vulnerable to disturbance and manipulation by park operations and visitors. Wildlife photographers and well-meaning wildlife enthusiasts have used mice to bring owls closer. Several pairs of spotted owls have been documented frequenting campgrounds, flying down to hikers, and roosting near homes. In Marin County, we have developed a modified protocol that reduces the number of mice used to obtain the relevant nest site and reproductive information. The ease of access to nest sites and high visibility of nesting structures facilitates intensive nest checks as opposed to using mice to monitor reproductive status. We rely on increased search time, more frequent visits and owl behavioral observations to gather the data. Overall we have reduced the use of mice, while still maintaining our ability to obtain accurate reproductive data.

## Study Area

In 2006, the historic study area was redefined by applying a 400 meter (1/4 mile) buffer around forested lands identified through the habitat model (Stralberg et al. in prep.) and restricting our study area to include buffered lands within 400 meters (1/4 mile) of the legislative boundaries of MUWO, PORE, and GOGA. In 2006 and 2007, all NPS surveys occurred within a 34,320-acre area of Marin County (Figure 1). California State Park (CSP) lands in Mount Tamalpais State Park and Samuel P. Taylor State Park are included in the study area, but Tomales Bay State Park is outside of the federal boundary thus its spotted owl habitat and known territories have been excluded from the study and are not included in the acreage calculation. Also not included in the acreage calculation, are additional management surveys that occurred outside the perimeter of federal lands on CSP, the City of Mill Valley, and the Marin Municipal Water District (MMWD) lands.

Wet winters and dry summers characterize the Mediterranean climate in Marin County. Rainfall varies according to topography and the ocean influence keeps temperatures moderate year-round. Elevations range from sea level to 784 meters on Mount Tamalpais in southern Marin County.

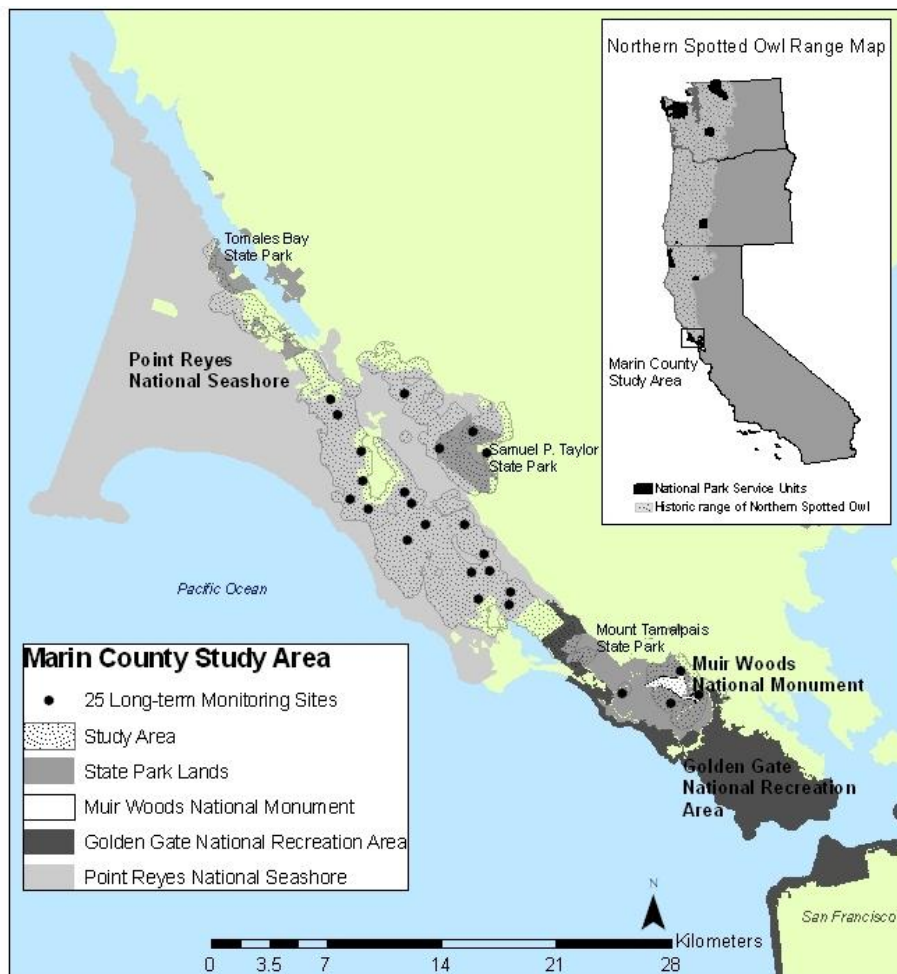


Figure 1. 2007 NPS spotted owl sites and study area.



# Methods

## 2007 Study Design and Site Selection

In 2007, the process of selecting 25 long-term monitoring sites began with a review of the study area. All known spotted owl activity sites that had been surveyed during inventory years in 1997, 1998, and 2006 were selected, regardless of results, to compile a list of approximately 66 owl sites. Initially, eight sites were removed that were known to have access issues due to private landownership, unsafe access, or because the sites were duplicative of other sites. Upon reviewing the list of unselected sites, two were added back into the potential sample population. These two sites had not been selected in the GIS analysis because the sites were outside the habitat model, but they were still within the legislative boundaries. The list of 60 sites was further narrowed to only include sites with pair status in at least one year from 1997 through 2006. From the approximately 47 sites with at least one year of pair status, a list of 25 sites was sub-selected using a set of random numbers generated in Microsoft Excel. To establish the final sample population for fecundity monitoring, a total of five sites had to be removed and randomly replaced due to safety concerns of the law enforcement staff of GOGA and PORE. With a sample size of 25 sites, the monitoring program has approximately 82% power of detecting a 10% annual decline in fecundity over 12 years (Connor and LeBuhn 2007). We anticipate the each year there will be sites that will need to be monitored for management purposes, but those sites will not be included in the fecundity analysis.

All long-term monitoring surveys (1999-2005 and 2007) for occupancy and reproductive information follow the Marin Modified Protocol developed for use in areas with high potential owl/human interaction. The “Modified Protocol for Spotted Owl Monitoring and Demographic Studies in Marin County California” (Fehring et al. 2001) is modeled directly from the widely used “Spotted Owl Monitoring Protocols for Demographic Studies” (Forsman 1995). An annual breeding status is assigned to the individual owl territories monitored and is determined using the Marin Modified Protocol. During the inventory years (2006), we used a hybrid of the Marin Modified Protocol and the U.S. Fish and Wildlife Service’s “Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls” (USFWS 1992) to define survey methods and standardized search procedures (Jensen et al. 2006).

All owl activity centers (either nest location or major roost site) are recorded in GPS (Global Positioning System) coordinates using a Garmin 3+ or similar GPS unit. Roost sites or nest trees for which GPS satellite access is not available are mapped on topographic maps from compass bearings taken in the field and GPS coordinates are obtained by using ArcGIS 9.2 (ESRI 2007). Each year, at every known nest location, nest tree parameters are measured and surrounding habitat is described using a standardized methods found in the Monitoring Protocol (Adams et al. 2005).

All site search, owl detections, and nest record field data are compiled in a Microsoft Access database maintained at PORE. All areas surveyed are mapped using ArcGIS 9.2 GIS software program and the data layers are made available to agencies involved in land management and planning projects within Marin County. The 2002 through 2006 spotted owl location data was submitted to the CA Natural Diversity Database Project (Rarefind) and the Biogeographic

Information and Observation System (BIOS) database. In addition, we provide the U.S. Department of Fish and Game and the Marin County Development Agency with spotted owl locations.

## **Results and Discussion**

### **General Monitoring**

On December 11<sup>th</sup>, 2006, staff members assembled at MUWO to discuss the program objectives and monitoring methods in preparation for the 2007 season. Topics discussed at the meeting included revisions to the sampling protocol, staff and volunteer roles, barred owls, and public outreach products. As a result of the meeting, a training session was organized for volunteers and staff. On March 1<sup>st</sup>, 17 interested volunteers, NPS interns, and NPS staff convened at MUWO to review and discuss the topics including the project's objectives, spotted owl protocol, field methods, and data collection. Each field site (GOGA, MUWO, and PORE) received a training binder that included a new employee/volunteer training document, protocols, data forms, standard operating procedure documents, safety information, and background literature. The 2007 NPS field crews were composed of returning staff members and a few long-term volunteers.

On April 10<sup>th</sup>, spotted owl staff members met with interpretative staff at MUWO to determine the update process of the archived spotted owl website. A second objective of the April meeting was to share site updates and discuss any concerns or questions regarding the 2007 breeding season. As of April 10<sup>th</sup>, no spotted owl nesting attempts had been documented.

### **Occupancy Status**

From March 5<sup>th</sup> to July 23<sup>rd</sup>, the survey teams made 137 visits (mean visits/site = 5.5, range 2-10) to the 25 long-term monitoring sites. Based on established survey criteria, pairs of spotted owls occupied 72% or 18 of the 25 long-term monitoring sites. Although pair occupancy appears to be reduced in 2007, the percentage of sites occupied by pairs or single owls has remained fairly constant over the past 11 years at about 90% (Figure 2). The apparent decline in pair occupancy may be attributed to the high proportion of non-nesting pairs and a general decline in owl response rates and detections by researchers as opposed to an actual drop in the number of pairs. It should also be noted that the 1997 to 2005 data is based on 46 long-term sites, not selected at random. The 2006 data is based on 43 known (non-random) spotted owl territories and excludes the 22 inventory areas surveyed that year. The 2007 data is based on 25 long term sites randomly selected from sites that had pair occupancy in at least one year from 1997 through 2006.

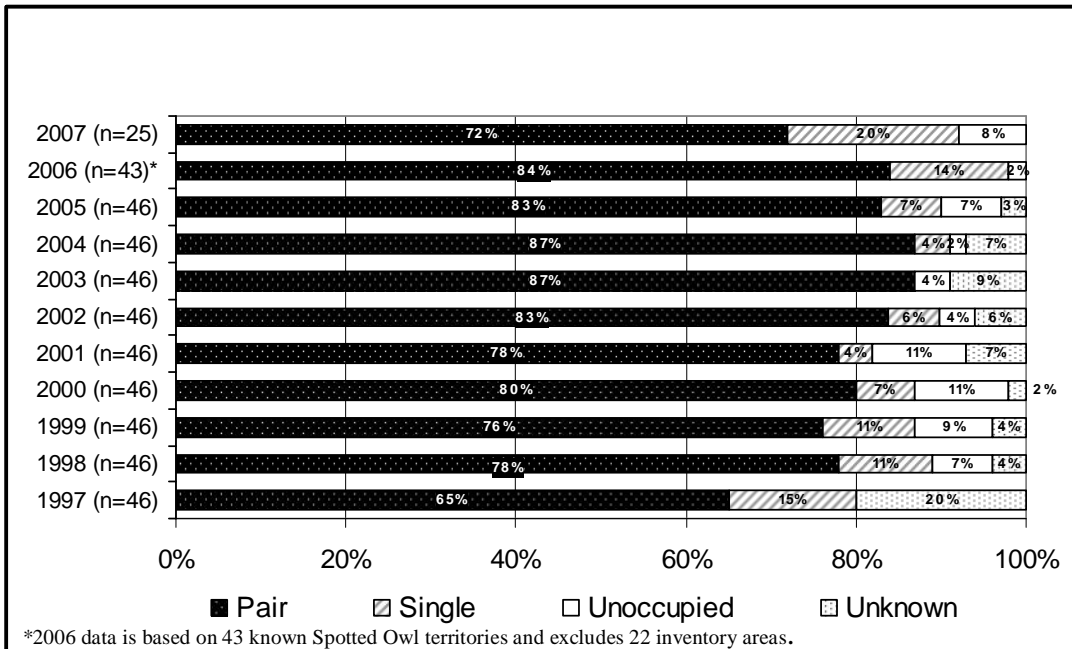


Figure 2. Occupancy status for all study sites (1997-2007).

## Reproductive Status and Fecundity

At the 25 sites monitored for reproductive status in 2007, 18 sites had pair status. Of the 14 females with known reproductive status, which included one non-nesting (resident single) female, all 14 females were confirmed non-nesting. To address a concern of late nesting versus non-nesting, biologists attempted to relocate 50% of the pairs that had been classified as non-nesting during the April 15<sup>th</sup> to May 1<sup>st</sup> protocol window to re-confirm non-nesting by observing the female for a second 60 minute period from May 2- May 15<sup>th</sup>. No late nesting attempts were detected in that sub-sample. The mean fecundity for the 2007 breeding season was 0.00 (n=14). There was no evidence to suggest nesting at the remaining five sites with pair status, but we were unable to meet the protocol requirements to confirm their reproductive status.

Table 1. 2007 Marin County spotted owl monitoring results.

| Number of sites monitored | Percentage of occupied territories | Percentage of occupied by pairs | Number of sites with known outcomes | Number of nests located | Number of young produced | Fecundity |
|---------------------------|------------------------------------|---------------------------------|-------------------------------------|-------------------------|--------------------------|-----------|
| 25                        | 92%                                | 72%                             | 14                                  | 0                       | 0                        | 0.00      |

While some study areas in the northern spotted owl's range exhibit alternating years of good and poor reproductive success, referred to as the "even-odd effect" (Franklin et al. 1999), the mean fecundity measured at long-term monitoring sites in Marin County has remained relatively stable, with an average fecundity of 0.46 (SE  $\pm 0.078$ ) for the years 1998 to 2005. Fecundity ( $\pm$  SE) is defined as the number of female young fledged per territorial female.

2007 marked the first year since the onset of this monitoring program in 1997 that there was no reproduction at any monitored spotted owl site on federal lands in Marin County (Table 1 and Figure 3). The poor reproductive success documented in Marin County mirrored the low



fecundity rates observed in the entire coastal California study area during the 2007 breeding season (NPS, Kristin Schmidt, Redwood National Park Wildlife Biologist, e-mail, 9/18/07). The synchrony seems to indicate climate as a direct or indirect trigger, affecting an aspect of spotted owl biology such as prey (Courtney et al. 2004).

The 2006 inventory data was excluded from the analysis since breeding information was collected opportunistically. However, we did detect 15 nesting pairs and found evidence of 17 young produced indicating it was a breeding year.

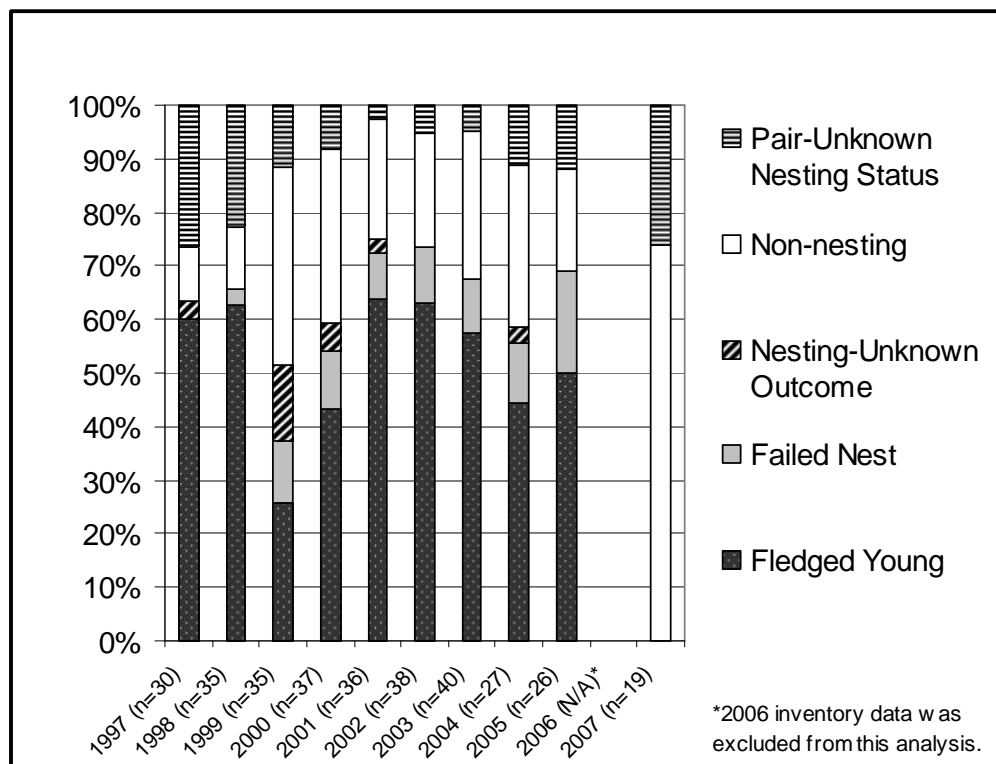


Figure 3. Reproductive status for owl pairs monitored in Marin County (1997-2005 and 2007).

Biologists positively sexed and aged a total of 30 (15 males and 15 females) spotted owls in 2007. In other study areas where banding occurs, sexing and aging is easily determined with a resight of the owl's band, but in the Marin study area only a small proportion of the owls are banded. The combination of decreased response rates associated with a non-breeding season (Forsman 1983) and the high incidence of unbanded owls made correlating an owl's sex and age difficult in 2007.

On numerous occasions when a single owl or pair was located, but without band identification, biologists relied on sexing the owl in view based on vocalizations and aging the owl based on tail feather wear (Forsman 1983). Many owls remained silent during daylight survey hours and only vocalized at night making it impossible to assign ages to the corresponding sex, resulting in an overall decrease of age determinations in the 2007 site status summaries. Adults constituted 80% or 24 of the 30 spotted owls whose age was identified in 2007. Five second-year sub-adults (17%) and one sub-adult in which the age could not be further determined (3%) were located. At 13 spotted owl territories, biologists were able to age both pair members. Forty-six percent of the

13 pairs in 2007 were composed of an adult and sub-adult (Figure 4). In comparison, only 26% of all known age pairings from 1997-2007 included either a sub-adult pair member or two sub-adults (Figure 5).

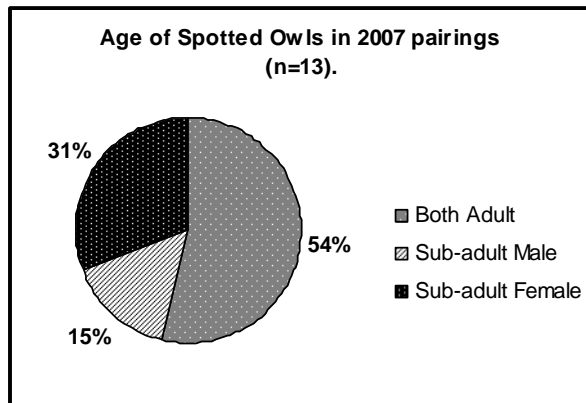


Figure 4. Age of spotted owls in 2007 pairings.

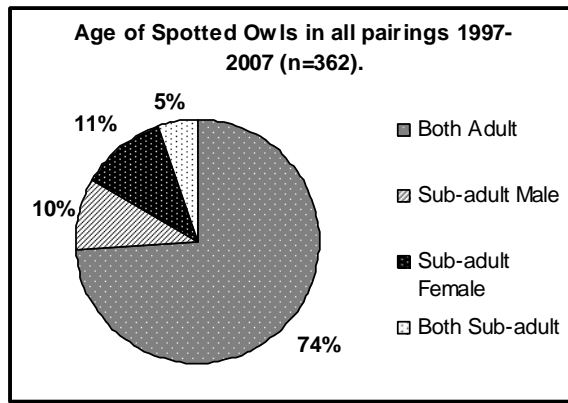


Figure 5. Age of spotted owls in all pairings.

## Identifications of Banded Owls

Between 1998 and 2003, 110 spotted owls were captured and color banded at 26 sites within a 24,700 acre study area centered around Bear Valley in PORE. In 2004, the banding aspect of the project was ceased due to logistical constraints and limited sample size. We have continued to identify the presence or absence of color bands on all spotted owls encountered.

Of the 110 spotted owls banded, 50 were banded as juveniles, 23 as subadults, and 37 as adults. In 2007, 10 banded owls were resighted (2 females and 8 males). Of the 10 band resights in 2007, one occurred at a management site. A total of 12 spotted owls (9 juveniles and 3 adults) whose identity has been positively determined have been resighted at new territories since 1999. The banded owls that dispersed to a new territory include 9 of the 50 owls banded as juveniles as well as 3 males banded after their juvenile year. The resighted juveniles moved an average distance of 9.4 km (n=9) from their banding location (nest site). The shortest distance moved by a juvenile was 2.0 km and the longest was 22.5 km. Four of these owls were detected outside the study area at other sites within Marin County. Two sub-adult males moved distances of 5.7 km and 6.4 km while one adult male relocated to the adjacent territory 1.0 km away. The average distance the three non-juveniles moved was 4.4 km.

## Barred Owls and Hybrids

Barred owls are a species of owl from the Eastern U.S. that has moved across the Canadian Rocky Mountains and down the West Coast of the United States. The U.S. Fish and Wildlife Service's 2007 Northern Spotted Owl Draft Recovery Plan identifies competition from barred owls as the most important threat currently facing the recovery of the northern spotted owl (USFWS 2007).

Barred owls are slightly larger than spotted owls and appear to exhibit aggressive behavior toward spotted owls. The first barred owl record for Marin County occurred in May 2002 in MUWO. Physical confrontations and aggressive interactions between barred and spotted owls

have been documented at multiple spotted owl sites within Marin County. Temporary and permanent displacement of spotted owl pairs from their historic sites as a result of the immigration of the barred owls into the spotted owl's range has been documented by biologists in the Pacific Northwest (Gremel 2000). Marin County is likely to see a similar effect, but the ramifications of barred owl occupancy on reproductive success of the northern spotted owls are not yet known.

In 2007, seven separate detections of male barred owls were recorded during spotted owl surveys at the 25 long-term monitoring sites. Of the seven surveys that incidentally detected a barred owl, only one visit also detected a spotted owl. During a night survey on May 10<sup>th</sup>, a single male spotted owl responded intermittently for 16 minutes before a male barred owl flew into the spotted owl's location and vocalized continuously for period of about 10 minutes. Four of the 7 barred owl detections occurred at two spotted owl sites in the Olema Valley. The remaining three detections were concentrated in the Redwood Creek drainage of MUWO.

In response to incidental observations of an adult barred owl and a fledgling on June 14<sup>th</sup> by MUWO staff, biologists completed four surveys for the specific purpose of collecting information on the barred owls at MUWO. The biologists focused on confirming barred owl occupancy and reproductive status, and assessed the possibility of placing color bands on the adults and fledglings. On June 20<sup>th</sup>, biologists positively confirmed with visual and vocal observations a barred owl pair and two fledglings within redwood habitat of a historic spotted owl territory at MUWO. Two additional follow-up visits were made in attempts to band the barred owls, and on July 11<sup>th</sup>, the barred owl pair and one fledgling were resighted. No barred owls were banded in 2007. This was the first confirmed breeding by barred owls in Marin County (or the study area or both).

Since barred owls in Marin County are not marked, the exact number of individuals cannot be confirmed. Based on the sex determination, frequency and repetition of the incidental barred owl detections, and distance between barred owl detections though, it is likely that at least two males and a female are current residents of federal lands in Marin County. This is the sixth year a male barred owl has been detected at MUWO, the fourth year a male barred owl was located on the west side of the Bolinas Ridge, and the first year a female has been observed at MUWO. This is the first year successful breeding of barred owls has been documented in Marin County. To date, no spotted/barred owl hybrids have been detected at any of the long term monitoring sites.



## Research Activities and Recommendations

### Barred Owl Study

Currently there is a great need to study barred owl and spotted owl interactions, to determine the nature of the threat, and identify potential management options to ensure the persistence of spotted owls throughout their historic range (USFWS 2007). The NPS and other agencies are hoping to implement studies across the northern spotted owl's range to gain a better understanding of the interspecific behavior and to learn more about management options to benefit spotted owls in the presence of barred owls. Since the barred owl has only recently invaded the southern extent of the northern spotted owl's range, Marin County offers a unique opportunity to study the early patterns of contact between barred and spotted owls. In Marin County, researchers will continue to track barred owl observations and make efforts to color band barred owls to facilitate tracking individual owls. Staff members and volunteers will continue to be made aware of the potential of hybridization and the importance of confirming the identity of both pair members. In future years, we will investigate the possibility of implementing a barred owl telemetry study to track barred owl movements, predict areas likely to see barred and spotted owl interactions, provide insight to the overlap of diet, habitat use, and interspecific behavior.

### Vocalization Study

During the 2006 and 2007 breeding seasons, spotted owl staff members worked with independent researcher, Rick Johnson, to investigate the potential of identifying individual northern spotted owls through vocalization analysis. Vocal identification has been proven to be an effective tool to distinguish between individuals in the genus *Strix*, specifically the African wood owl (*Strix woodfordii*) (Delpont et al. 2002). The purpose of the research project was to determine if recordings of owl vocalizations, specifically four note locations calls, can be used to identify individual birds. The use of vocalizations as an alternative to banding for individual identification has been proposed for the Mexican spotted owl (*Strix occidentalis lucida*) (Kuntz and Stacy 1997).

Initially, six spotted owl sites were selected based on the criteria that at least one of the pair members had color bands present during the 2005 field season. Four additional spotted owl sites were incorporated into the study over the course of the 2005 field season. All sites were located on NPS lands. Unsolicited and solicited male and female vocalizations were recorded during day and night surveys. The sounds are studied using spectrograms (Figure 6) and five parameters were selected to evaluate the spectrograms. The timing of the calls, pitch of the fourth note, and shape of the fourth note were used to distinguish individual owls. These quantitative measures are based on previous work on northern spotted owls and California spotted owls (Van Gelder 2003). Preliminary results indicate that currently identification of individual spotted owls by vocalization alone is not likely to be an efficient monitoring tool for project staff to utilize in a demographic study. The vocalization study will continue collecting vocal recordings spotted owls and barred owls in 2008. This technique may prove to be appropriate for the identification of a smaller population of barred owl individuals.

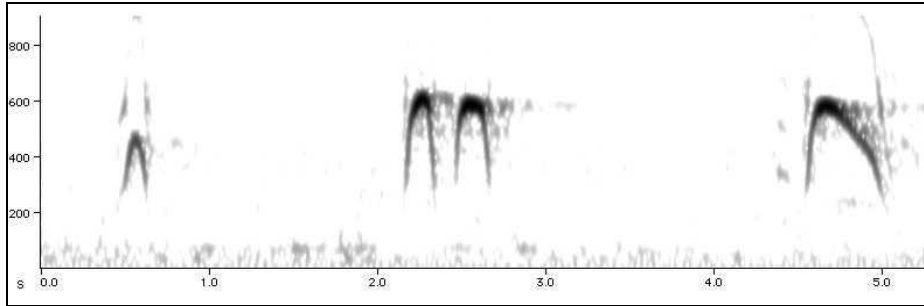


Figure 6. Spectrogram of a spotted owl four-note location call.

## Sudden Oak Death

Marin County is one of 14 counties in California affected by the pathogen *Phytophthora ramorum* that causes sudden oak death (SOD). *P. ramorum* is a water mold that acts like a fungus, attacking the trunk of a tree and causing a canker, or wound that eventually cuts off the tree's flow of nutrients. Other secondary decay organisms such as beetles and fungi often move in after the tree is infected. Trees infected with SOD may survive for one to several years as the infection progresses. As the tree finally dies, the leaves may turn from green to brown within a few weeks, hence the appearance of sudden death (Davidson et al. 2003). Tan bark oaks and coast live oaks are killed by the disease; other species affected are known as "foliar hosts" because their leaves and twigs may be infected. These foliar hosts can spread the disease, but are only occasionally killed.

The diversity of host species affected by *P. ramorum* indicates potential long-term landscape modifications through changes in the forest canopy, understory, and ground layer (Rizzo and Garbelotto 2003). A large scale habitat change due to *P. ramorum* has the potential to affect the whole forest ecosystem. Specifically, SOD has the potential to affect spotted owls through loss of canopy cover in roosting and nesting areas and changes in prey species due to loss or changes in prey habitat. Spotted owl habitats affected by oak die-offs as a result of SOD are located in Samuel P. Taylor State Park, Mt. Tamalpais State Park, MUWO, Mill Valley, GOGA, and PORE. For comprehensive information regarding SOD and links to current maps visit the California Oak Mortality Task Force website at [www.suddenoakdeath.org](http://www.suddenoakdeath.org).

Management of the pathogen at the spotted owl project level includes incorporating measures to prevent the spread of *P. ramorum*. As the range of SOD expands, simple precautionary measures and decontamination procedures have been added to the monitoring efforts so that owl biologists do not facilitate the transfer of infected plant material or soil to unaffected areas.

## West Nile Virus

West Nile virus (WNV) is an arbovirus that first appeared in the Western Hemisphere, specifically New York, in the early fall of 1999. Mosquitoes and migratory birds are the main species involved in the spread of WNV. Mosquitoes are the principle vector and avian species are considered the principle host species for WNV. WNV first appeared in California in 2002. By 2004, WNV had spread to all 58 counties of California and a total of 3,232 birds tested positive for WNV. Statewide, the incidence of WNV has continued to decrease with only 1,446 birds testing positive in 2006. On a local level, since reaching a peak in 2004 of 18 birds testing

positive for WNV in Marin County, numbers have continued to steadily decline. As of September 2007, no birds have tested positive for WNV in Marin County. The top three bird species infected by WNV in California are the American crow (*Corvus brachyrhynchos*), western scrub-jay (*Aphelocoma californica*), and yellow-billed magpies (*Pica nuttalli*). For historical and current information that is updated weekly visit <http://westnile.ca.gov/>.

Raptors and owls have been noted to be particularly susceptible to WNV. A spotted owl was confirmed to have died from WNV at a captive wildlife facility, indicating that spotted owls are susceptible to WNV. WNV has been detected within the family Strigidae in California. Future efforts will be made to document fatalities potentially resulting from West Nile Virus. Carcasses should be tested whenever possible and the population should continue to be monitored for declines due to this new threat.





## Management Activities and Recommendations

Humans and their activities, including development along the wildland/urban interface, land management practices, and recreation are among the significant sources of impact in Marin County. In addition, the continued range expansion of the barred owl poses a competitive threat to spotted owls throughout their range (USFWS 2007). We recommend that owl occupancy and reproductive monitoring surveys continue, and that land managers use these data to ensure that management activities do not impact the habitat or the productivity of northern spotted owls. We encourage continued communication between land managers and their maintenance crews in planning and executing projects in spotted owl habitat. Information on owl site locations should continue to be made available to USFWS, all land managers and local city and county planning departments. The central repository for owl detection information in California is the California Department of Fish and Game (CDFG) Natural Diversity Database ([www.dfg.ca.gov/whdab/html/cnddb.html](http://www.dfg.ca.gov/whdab/html/cnddb.html)) and the Biogeographic Information and Observation System (BIOS) database that is managed by Gordon Gould of the CDFG.

Given the mixed ownership patterns in Marin County, several owl home ranges contain both public and private lands. Coordination between park managers and local planners is essential. Loss of owl habitat and owl pairs due to residential land management practices (e.g., rodenticide) and urban development is an urgent local threat. Due to the fragmented and isolated nature of the Marin County owl habitat, declines along the urban edges may impact overall population health throughout the local range.

### Public Outreach

Due to the consistent public interaction with Marin County's northern spotted owl population, the NPS is taking a proactive approach to inform the public of their role of living and working in areas with spotted owls. The National Park Service is currently updating an owl informational brochure and website. The goal of the brochure and website is to introduce Marin County residents, land owners, and agency managers to basic spotted owl biology, guidelines for protecting spotted owls and owl habitat in this county, and how to minimize potential threats to spotted owls. In 2007, additional outreach included: 1) a letter distributed to local birding groups and leaders in spring of 2007 outlining birding etiquette, 2) a request posted on a local birding website with the hope of drawing upon the knowledge of the birding community to locate additional barred owls in Marin County, 3) spotted owl informational presentations were presented at the GOGA Symposium for Educators on February 15<sup>th</sup> and for the PORE trail staff, and 4) a barred owl executive briefing was completed to inform the public of the current status of barred owls in Marin County and the threat barred owls present to the recovery of the northern spotted owl. The barred owl executive briefing and additional information on the spotted owl project can be accessed at the San Francisco Bay Area Network Inventory and Monitoring Program website: [http://science.nature.nps.gov/im/units/sfan/vital\\_signs/Spotted\\_Owl/birds.cfm](http://science.nature.nps.gov/im/units/sfan/vital_signs/Spotted_Owl/birds.cfm).

## **Range-wide Spotted Owl/Barred Owl Meeting**

On February 21<sup>st</sup>, 2007 federal biologists convened in Portland for a workshop on the science of the northern spotted owl hosted by USFWS, BLM, and USFS. The conference provided spotted owl researchers with an opportunity to highlight several of the ongoing research projects and published results. Topics presented in the first half of the day focused on prey studies and the second portion of the day focused on the results of habitat and barred owl studies. In attendance from the Marin County spotted owl monitoring program were Bill Merkle (GOGA, Wildlife Biologist) and Heather Jensen (PORE, Biological Technician).

## Literature Cited

- Adams, D., K. Fehring, and B. Merkle. 2005. Draft Marin County Northern Spotted Owl Monitoring Protocol. Inventory and Monitoring Program San Francisco Bay Area Network National Park Service. U.S. Department of Interior.
- Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J. Hines, G. S. Olson, S. Ackers, S. Andrews, B Biswell, P. Carlson, L. Diller, K. Dugger, K. Fehring, T. Fleming, R. Gerhardt, S. Gremel, R. Gutierrez, P. Happe, D. Herter, J. Higley, R. Horn, L. Irwin, P. Loschl, J. Reid, S. Sovern. 2006. Status and trends in demography of northern spotted owls, 1985-2003. Wildlife Monographs No. **163**: 1-48.
- Barrowclough, G. F., J. G. Groth, L. A. Mertz, and R. J. Gutierrez. 2005. Genetic structure, introgression, and a narrow hybrid zone between northern and California spotted owls (*Strix occidentalis*). Molecular Ecology **14**: 1109-1120.
- Blakesley, J.A., W. La Haye, J.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Demography. Chapter in S P Courtney, J A Blakesley, R.E. Bigley, M.L. Cody, J. P. Dumbacher, R. C. Fleischer, A. B. Franklin, J. F. Franklin, R.J. Gutiérrez, J. M. Marzluff, and L. Sztukowski. Scientific evaluation of the status of the Northern Spotted Owl.
- Chow, N. and S. Allen. 1997. Assessment of Northern Spotted Owl After The Vision Fire Wildfire 1996. Unpublished report. Point Reyes National Seashore, Point Reyes, CA.
- Chow, N. 2001. Distribution and Habitat Associations of Northern Spotted Owls in Marin County, California. M.S. Thesis. Humboldt State University, Arcata, CA.
- Connor, E. and G. LeBuhn. 2007. Spotted Owl Fecundity Initial Power and Sample Size Estimates. Unpublished report. San Francisco State University, San Francisco, CA.
- Courtney, S.P., J A Blakesley, R E Bigley, M L Cody, J P Dumbacher, R C Fleischer, A B Franklin, J F Franklin, R J Gutiérrez, J M Marzluff, L Sztukowski. 2004. Scientific evaluation of the status of the Northern Spotted Owl. Sustainable Ecosystems Institute, Portland, Oregon.
- Davidson, J.M., S. Werres, M. Garbelotto, E.M. Hansen, and D.M. Rizzo. 2003. Sudden oak death and associated diseases caused by *Phytophthora ramorum*. Plant Health Progress, DOI:10.1094/PHP-2003-0707-01-DG.
- Delpont, W., A.C. Kemp, and J.W.H. Ferguson. 2002. Vocal identification of individual African Wood Owls *Strix woodfordii*: a technique to monitor long-term adult turnover and residency. Ibis 144: 30-39.
- Evens, J.G. 1988. The natural history of the Point Reyes Peninsula. Point Reyes National Seashore Association, Point Reyes, CA.

- Fehring, K., D. Adams, D. Hatch, and S. Allen. 2001. Modified Protocols For Spotted Owl Monitoring And Demographic Studies In Marin County, California - July 2001. Unpublished protocol. U.S. Department of the Interior, National Park Service, Point Reyes, CA.
- Fehring, K. E. 2003. Dusky-footed woodrat monitoring in Point Reyes National Seashore Final Report. Unpublished report, Point Reyes Bird Observatory, Stinson Beach, CA.
- Forsman, E. D. 1983. Methods and Materials for Locating and Studying Spotted Owls. USDA For. Serv. Gen. Tech. Rept. PNW-162. Pacific NW Res. Station. Portland. OR.
- Forsman, E. D., E. C. Meslow and H. M. Wright. 1984. Distribution and biology of the Spotted Owl in Oregon. Wildlife Monograph **87**:1-64.
- Forsman, E. D. 1995. Spotted Owl monitoring protocols for demographic studies, 29 March 1995. U.S.D.A. Forest Service, Corvallis Forestry Sciences Lab, 12 pp.
- Franklin, A. B., K. P. Burnham, G. C. White, R. G. Anthony, E. D. Forsman, C. Schwarz, J. D. Nichols and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, OR.
- Gremel, S. 2000. Barred owl displaces northern spotted owl at Olympic. Natural Resource Year in Review - 2000. National Park Service, U.S. Department of the Interior (publication D-1459).
- Henke, A. L., T. Chi, C. Brinegar, and J. Smith. 2003. Preliminary Microsatellite Analysis of Two Populations of Northern Spotted Owls (*Strix occidentalis caurina*). Unpublished report. Conservation Genetics Laboratory, Department of Biological Sciences, San Jose State University, San Jose, California.
- Jensen H.J., D.B. Adams, and W.W. Merkle. 2005. Monitoring Northern Spotted Owls in Marin County, California: 2005 Annual Report, NPS report.
- Jensen, H.J., D.B Adams, and W.W. Merkle. 2006. Northern Spotted Owl Inventory on Federal Lands in Marin County, 2006 Annual Report. NPS/PWR/SFAN/NRR – 2007/004. San Francisco Bay Area Network, Golden Gate National Recreation Area, Fort Cronkhite, Sausalito, California.
- Kelly, E. G., E. D. Forsman, and R. G. Anthony. 2003. Are Barred Owls Displacing Spotted Owls? Condor 105: 45-53.
- Kuntz, W. A. and P. B. Stacey. 1997. Preliminary investigation of Vocal Variation in the Mexican spotted owl (*Strix occidentalis*): Would vocal analysis of the Four\_note location call be a useful field tool for individual identification? Pages 562-568 in J. R. Duncan, D. H. Johnson, and T. H. Nicholls, editors. Proceedings of the Second International

Symposium on Biology and Conservation of Owls of the Northern Hemisphere. United States Forest Service General Technical Report N C, No.

- Rizzo, D. M., and M. Garbelotto. 2003. Sudden oak death: endangering California and Oregon forest ecosystems. *Front Ecol. Environ* **1**(5): 197-204.
- Stralberg, D., K. E. Fehring, N. Nur, L. Y. Pomara, D. B. Adams, D. Hatch, G. R. Geupel, and S. Allen. In Prep. Comparative analysis of habitat-based distribution models for the Northern Spotted Owl at its southern range limit in central California: the importance of locally derived models.
- USFWS. 1992. Protocol for surveying proposed management activities that may impact Northern Spotted Owls. 7 March 1991, revised 17 March 1992. Endorsed by U.S. Fish and Wildlife Service.
- USFWS. 2007. 2007 Draft Recovery Plan for the Northern Spotted Owl, *Strix occidentalis caurina*: Merged Options 1 and 2. Portland, Oregon.
- Van Gelder, J.J. 2003. Variation in Four-note Location Calls of Male Spotted Owls (*Strix occidentalis*). M.S. Thesis. Humboldt State University, Arcata, CA.

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